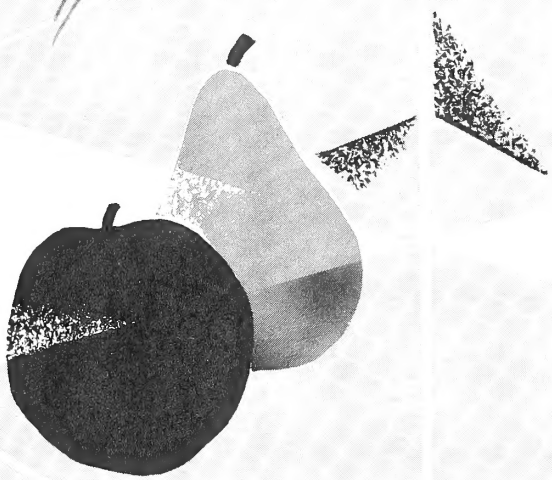
# EVALUATION OF AND FOR PEARS AND APPLES



Marketing Research Report No. 530

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Agricultural Marketing Service

Transportation and Facilities Research Division


Growth Through Agricultural Progress

## PREFACE

The study on which this report is based is part of a broad program of research seeking to increase the salability of farm products and to lower the cost of marketing them. This phase of the research aims at the development of new or improved packages, shipping containers, packing materials, and methods of packing a variety of agricultural commodities. By reducing damage and deterioration in transit and extending shelf life, these improvements make possible the delivery of a better product to the consumer.

Recent related reports on improved packages and containers for fruits and vegetables include:

Evaluation of Shipping Containers for Washington Cherries, MRR 426, September 1960

Packaging California Cauliflower, MRR 414, July 1960

Prepackaging California Grapes at Shipping Point, MRR 410, July 1960

Prepackaging Early California Potatoes at Point of Production, MRR 401, June 1960

Prepackaging Firm Ripe Peaches, AMS-312, June 1959

Evaluation of Shipping Containers for Western Lettuce, MRR 248, July 1958

Evaluation of Shipping Containers for Florida Avocados, MRR 228, May 1958

Packing California Potatoes in Fiberboard Boxes, MRR 214, February 1958

Development of Carrot Prepackaging, MRR 185, June 1957

Fresh Fruit and Vegetable Prepackaging, Northeastern Region, MRR 154, February 1957

New Shipping Containers for Plums, MRR 128, June 1956

Washington, D. C. April 1962

## ACKNOWLEDGMENTS

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Apple Growers Association
Perham Fruit Corporation
George F. Joseph Company
Marley Orchards
Gleed Cold Storage and Packing Company
Michelsen L. P. Company
Friday Pack Company
Keyes Fibre Company

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## SUMMARY

Washington and Oregon apple and pear shippers are seeking more efficient ways of getting their product to the consumer in better condition.

To help them, packaging specialists of the Agricultural Marketing Service during the 1960-61 season evaluated experimental shipping containers and packing materials for these fruits. These were: (1) Polyurethane place-packs for apples, (2) polyurethane place-packs for pears, (3) apple tray-packs for pears, and (4) a 5-layer tray-pack for size-88 apples.

Polyurethane Place-Pack for Apples.--Apples were place-packed on an 1/8-inch polyurethane pad in each layer of the shipping container. The pad was the same, regardless of the size of the apples. In the conventional molded pulpboard trays, the number of cups per tray varied with the size of the apples packed. Place-packing apples on a single-sized layer pad in a master container smaller than the conventional one allowed savings in inventory, materials, storage and shipping costs. However, the polyurethane cushioning material used was not adequate in thickness and density to protect the apples from bruising. Although three test shipments of medium-size to small Red Delicious apples made early in the season in the polyurethane place-pack and standard tray-pack showed almost equal amounts of bruising, shipments of larger apples late in the season showed more than 25 percent bruising in the place-pack in contrast to about 10 percent in the standard tray-pack. Winesaps sustained about 21 percent bruising in the place-pack in contrast to 8 percent in the standard tray-packs, and Golden Delicious sustained 18 percent in the place-pack in contrast to 3 percent in the conventional cell pack with a partition for each apple. Too, the bruising was usually of a more serious nature in the polyurethane place-pack.

Polyurethane Place-Pack for Pears.--The same economies of material and shipping costs and less tare weight, as mentioned above, are true for pears as well. The experimental polyurethane place-pack carried the pears to market with almost no bruising and little discoloration, largely because of the shape of the pear and its ability to stand more pressure. The shape of pears, with their necks, allowed better "nesting" and the polyurethane is so resilient that this pack for pears is very comparable to a bulk pack in a standard wooden box.

Apple Tray-Pack for Pears.--Many pear shippers who are also apple shippers would like to economize by using apple pulpboard trays for pears to permit the use of the same size master container. Apple trays from two different manufacturers were tested. No material difference was noted in the arrival condition of the pears by type of trays. The pears arrived with less bruising in the tray-pack, 2.1 percent, than in the standard pack, 7.8 percent. However, more discoloration was found in the tray-pack, 9.6 percent, as compared to 1.7 percent, because the pears in the tray-pack could move more than those in the wooden box. The use of a better compression pad on top to avoid headroom might help. It is probable that the pears would move less if a tray was

designed to conform to the shape of pears. More testing is needed before any conclusions are drawn.

Five-Layer Tray-Pack for Size-88 Apples.--The size-88 apple is usually packed in pulpboard trays 4 layers deep in the master container. Many shippers reported more excessive bruising in the size-88 pack than with other sizes of apples. New pulpboard trays, designed with 17 and 18 cups per tray, were packed alternately 5 layers deep per box, in contrast to the 4-layer-deep pack of the conventional 22-unit trays. Controlled test shipments showed apples packed in the new five-layer pack sustained less total bruising--about 10 percent--than comparable apples in the standard four-layer pack, which was approximately 24 percent. The bruising also was of a less serious nature. The pressure on the apples seemed more widely distributed in the five-layer pack with staggered cups than in the four-layer pack.

# EVALUATION OF SHIPPING TRAYS AND PADS FOR PEARS AND APPLES

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## BACKGROUND

The Washington and Oregon apple and pear industries, aware of rising costs of labor and materials, long have wanted less expensive packs which would provide more protection for their fruit in transit from the packinghouse to the retail store. With new materials being developed, the industries are uncertain about the advantages and disadvantages of changing a substantial part of their production from the conventional packs to new experimental containers.

This study was undertaken to evaluate new experimental shipping containers and packing materials proposed for apples and pears. When possible, direct labor requirements, material costs, and shipping costs were recorded at four packing plants. Limited supplies of the new materials and pilot methods of packing made the use of time studies for some packs not feasible. Condition on arrival of the fruit and trade acceptance of the new packs were determined at terminal markets by specialists of the Agricultural Marketing Service.

The following are the more promising of the newly developed packs. They were test-shipped by rail from Washington and Oregon packing plants to eastern markets.

Polyurethane place-pack for apples:
- 3 shipments of Red Delicious from plant A
- 4 shipments of Red Delicious from plant B
- 4 shipments of Winesaps from plant B
- 3 shipments of Golden Delicious from plant C

Polyurethane place-pack for pears:
- 5 shipments of Anjous from plant A

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Apple tray-pack for pears:
2 shipments of Anjous from plant E

Five-layer tray-pack for size-88 apples:
3 shipments of Red Delicious from plant D

## DESCRIPTION OF EXPERIMENTAL PACKS

### Polyurethane Place-Pack for Apples

The container generally used for the new polyurethane place-pack for apples was a full-telescope fiberboard box with inside dimensions of 18 1/8 by 11 3/8 by 11 inches. This box is known by the trade as the bulk bushel container and is smaller than the tray-pack container. Use of a smaller container was possible because apples in a place-pack are closer together than apples in a tray-pack. One shipper used an "all flaps meet" bottom. The usual box was a half-slotted container whose flaps did not meet on either top or bottom. The polyurethane pads were 1/8 inch thick and were used between layers in lieu of molded pulpboard trays (fig. 1). A pad of shredded paper encased in a paper envelope--hereafter called a shredded-paper pad--was used on top.

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Figure 1.--Apples are place-packed on polyurethane layer-pad in conventional fiberboard shipping container.

### Polyurethane Place-Pack for Pears

The container used for the polyurethane place-pack for pears was a full-telescope fiberboard box with inside dimensions of 18 1/8 by 11 1/8 by 11 inches. The polyurethane pads were 1/8-inch thick and were placed on the bottom, between layers, and on top (left, in fig. 2).

### Apple Tray-Pack for Pears

The tray-pack tried for pears was the same as the conventional apple tray-pack (right, in fig. 2). The container was the standard full-telescope fiberboard box with inside dimensions of 19 3/4 by 12 by 11 3/4 inches. The molded pulpboard apple

trays with a cup for each fruit were made by two different manufacturers. A shredded-paper pad was used on top.

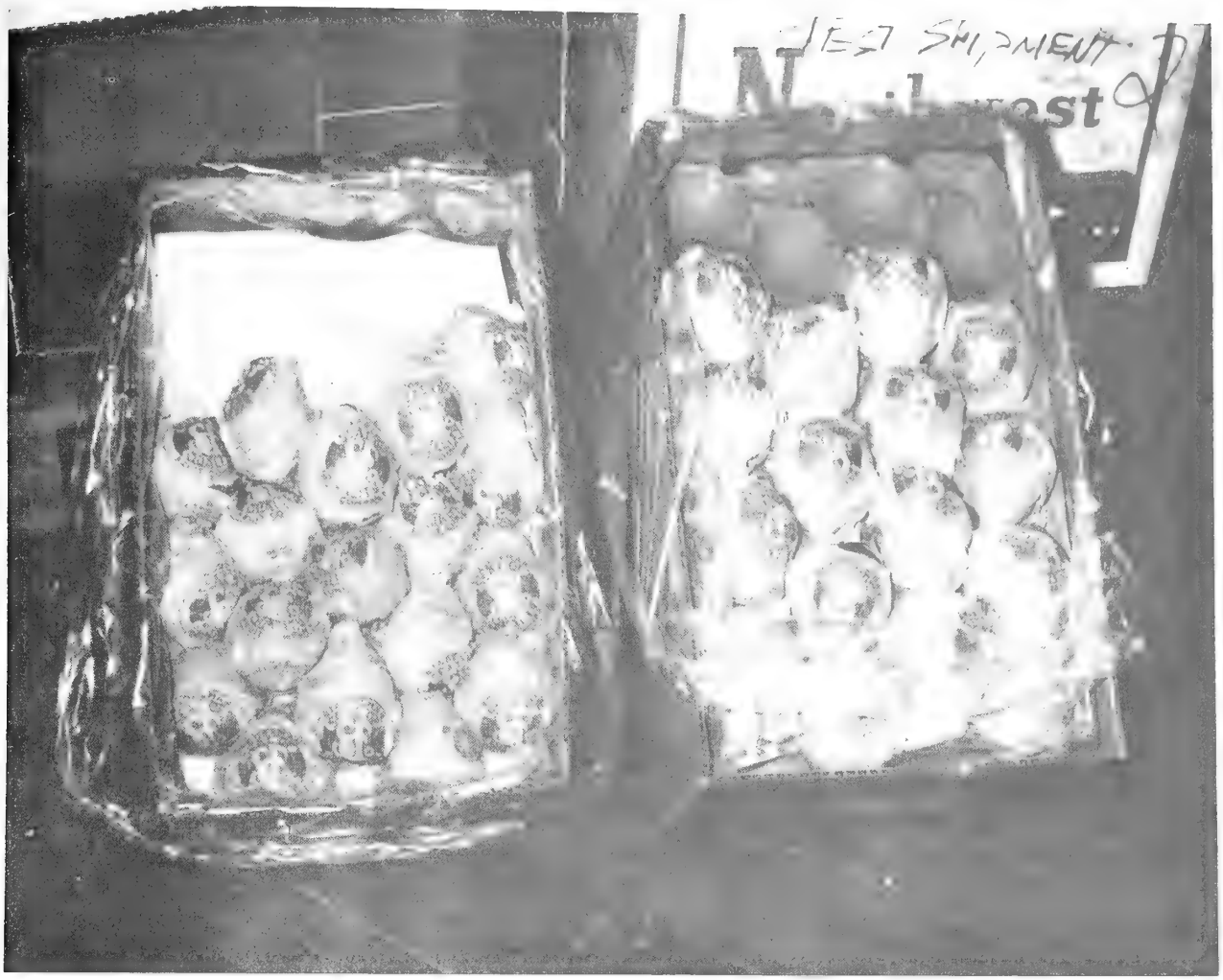

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Figure 2.--Pears are place-packed on a polyurethane pad (left). Pears are packed in the rounded cups of a standard apple shipping-tray (right).

The following list shows the apple tray sizes, the pear size packed in each, and the number of trays per box of pears:

| Apple tray size | Pear size | Number of trays per box |
|---|---|---|
| 80 | 100 | 5 |
| 88 | 110 | 5 |
| 100 | 120 | 6 |
| 113 | 135 | 6 |
| 125 | 150 | 6 |

## Five-Layer Pack for Size-88 Apples

The master container used for the new five-layer 88-size molded pulpboard trays was exactly the same as that used for the standard tray-pack for apples. The conventional four-layer size-88 trays hold 22 apples per tray, four trays per master container. The new trays were designed to hold 17 and 18 apples per tray; three layers held 18 apples each, two held 17 apples each, giving a five-layer pack with the same total of 88 apples per box. When packed with four layers of the conventional trays, the master containers usually were slack upon arrival at the terminal. With five layers of the new trays, the pack was tight.

# COST OF PACKING MATERIALS

## Polyurethane Place-Pack for Apples

Table 1 compares the cost of materials used in the standard tray-pack and in the polyurethane-pad place-pack for apples. The experimental place-pack cost just under a tenth of a cent less per pound of apples packed.

Table 1.--Comparative cost of materials used in standard tray-pack and in the polyurethane-pad pack for apples, 1961

| Materials | Standard tray-pack | Polyurethane place-pack with shredded-paper top pad |
|---|---|---|
| | Cents | Cents |
| Box, top and bottom | 30.7 | 28.3 |
| 5 molded pulpboard trays | 20.5 | --- |
| 5 polyurethane pads | --- | 19.7 |
| Shredded-paper top pad | 2.0 | 2.0 |
| Tissues | 8.0 | 8.0 |
| Staples | 0.6 | 0.6 |
| Total | 61.8 | 58.6 |
| Cost per pound 1/ | 1.5 | 1.4 |

1/ At 42 pounds net per box.

## Experimental Packs for Pears

Table 2 compares the costs of packing materials for Anjou pears in the standard wooden box and in two experimental packs--the polyurethane-pad place-pack and the converted apple tray-pack.

Table 2.--Comparative costs of materials for packing Anjou pears in standard wooden box, polyurethane-pad place-pack, and converted apple-tray pack, 1961

| Materials | Standard wooden box | Polyurethane place-pack | Apple tray-pack |
|---|---|---|---|
| | Cents | Cents | Cents |
| Shook | 32.7 | --- | --- |
| Lid and cleats | 8.5 | --- | --- |
| Nails | 1.7 | --- | --- |
| Label and paste | 0.6 | --- | --- |
| Chipboard liner | 8.5 | --- | --- |
| Polyethylene liner | 6.6 | 6.6 | 6.6 |
| Tissue wraps, printed | 8.5 | 8.5 | 8.5 |
| 6 polyurethane pads | --- | 23.7 | --- |
| 5 pulpboard trays | --- | --- | 20.5 |
| Top pad | --- | --- | 2.0 |
| Fiberboard box | --- | 27.0 | 31.0 |
| Total per box | 67.1 | 65.8 | 68.6 |
| Total per pound 1/ | 1.49 | 1.46 | 1.52 |

1/ At 45 pounds net per box.

The experimental place-pack with polyurethane pads between layers had a slim advantage of 0.03 cent per pound of pears packed as compared with the standard wooden box. The apple tray-pack converted to use with pears cost 0.03 cent more per pound packed than the standard wooden box. Many growers pack both apples and pears; savings in inventory costs resulting from dual use of the same packing materials for both apples and pears probably would outweigh the slight difference in purchase costs.

### Five-Layer Pack for Size-88 Apples

Costs of containers and accessory packing material for the new five-layer tray-pack for size-88 apples are the same as the costs for the standard tray-pack with the addition of one tray per box. The additional tray costs about 4 cents, depending on quantity purchased. Costs for the average standard tray-pack are in table 1.

## AMOUNT AND COST OF DIRECT LABOR FOR PACKING

### Polyurethane Place-Pack for Apples

One man performed all the operations in packing both the standard tray-pack of apples and the new polyurethane place-pack for apples. With a 15-percent allowance for fatigue and personal time, it required 3.42 man-minutes for

the standard pack and 3.66 for the polyurethane pack. At an assumed wage of $1.50 per hour, the direct labor costs were 8.6 for the standard pack and 9.2 cents for the polyurethane pack per box.

These time studies were taken over a period of only 2 days. Therefore, the packers did not have the opportunity to acquire great skill in packing apples with the new method. The additional time required for the place-pack method was due largely to the polyurethane pad slipping as the packer placed the apples. This required frequent adjustment of the pad in order to make sure the entire layer beneath was covered.

## Apple Tray-Pack for Pears

Table 3 shows the direct labor requirements and costs for packing pears in the apple tray-pack as compared to the standard wooden box for pears. An hourly wage of $1.50 was assumed.

Table 3.--Direct labor requirements and costs of packing size-100 Anjou pears in specified types of containers, 1961 1/

| Operation | Standard wooden box | | Apple-tray pack | |
|---|---|---|---|---|
| | Labor requirements | Direct labor cost | Labor requirements | Direct labor cost |
| | Man-minutes | Cents | Man-minutes | Cents |
| Packing | 3.73 | 9.3 | 4.10 | 10.2 |
| Tying polyethylene liner | .36 | 0.9 | 2/ | --- |
| Stamping | .21 | 0.5 | .10 | 0.2 |
| Closing box | .07 | 0.2 | 2/ | --- |
| Gluing label | .08 | 0.2 | --- | --- |
| Total | 4.45 | 11.1 | 4.20 | 10.4 |

1/ Includes 15 percent for fatigue and personal time.
2/ Packer also ties polyethylene liner and closes box.

Packing pears in the apple tray-pack made possible a saving in direct labor costs of 0.7 cent per box.

Labor requirements and costs were not determined for the polyurethane place-pack for pears and the five-layer tray-pack for size-88 apples because all work with them was on a limited experimental scale.

## COMPARATIVE TRANSPORTATION COSTS

### Polyurethane Place-Pack for Apples

The tare weight of the polyurethane place-pack is 1 pound less than that of the standard tray-pack for apples--3 pounds instead of 4 pounds. Using the freight rate of $2.26 per 100 pounds from Washington and northern Oregon shipping centers to New York City, the lower tare weight permits a saving in transportation costs of 2.26 cents a box, or $18.98 per carload of 840 boxes.

### Polyurethane Place-Pack for Pears

The tare weight of the polyurethane place-pack for pears also was 3 pounds. The wooden box and accessory materials for the standard pack of pears was 5 pounds. With a cross-country freight rate of $2.05 per 100 pounds, not including refrigeration, the lower tare weight permitted a saving of 4.1 cents per box, or $38.05 per carload of 928 boxes.

### Apple Tray-Pack for Pears

The apple tray-pack used experimentally with pears was 1 pound lighter than the standard wooden box for pears, thus permitting a saving in transportation costs of 2.05 cents a box in a cross-country shipment of pears.

### Five-Layer Pack for Size-88 Apples

The experimental five-layer pack for size-88 apples was heavier than the standard four-layer pack only by the weight of one additional tray. With such a slight difference it probably would be assigned the same billing weight, thus neither adding to nor subtracting from transportation costs.

## EVALUATION OF PACKS AT TERMINAL MARKETS

In order to evaluate the protective qualities of the experimental polyurethane material for apples, 13 test rail shipments to eastern markets and 1 test truck shipment to California were initiated in 1960-61.

Table 4 shows the arrival condition of Red Delicious apples packed in the standard tray-pack and the experimental polyurethane place-pack; three of the shipments were made early in the season and four late in the season.

Table 4.--Condition on arrival of Red Delicious apples by type of pack, 3 early-season and 4 late-season shipments, 1960-61

| Season and type of pack | Size of apples | Amount of bruising | | | |
|---|---|---|---|---|---|
| | | Slight | Damage by bruising | Serious | Total |
| | | Percent | Percent | Percent | Percent |
| Early season: | | | | | |
| Standard tray | 100 | 7.0 | 0 | 0 | 7.0 |
| Do. | 113 | 8.8 | 0.9 | 0.3 | 10.0 |
| Do. | 125 | 5.9 | 0.3 | 0 | 6.2 |
| Average | | 7.2 | 0.4 | 0.1 | 7.7 |
| Polyurethane | 100 | 8.7 | 0.3 | 0 | 9.0 |
| Do. | 113 | 4.4 | 0.6 | 0 | 5.0 |
| Do. | 125 | 8.5 | 0 | 0 | 8.5 |
| Average | | 7.2 | 0.3 | 0.0 | 7.5 |
| Late season: | | | | | |
| Standard tray | 72 | 4.2 | 7.9 | 3.2 | 15.3 |
| Do. | 80 | 6.9 | 0.3 | 0.0 | 7.2 |
| Do. | 100 | 7.0 | 0.2 | 0.0 | 7.2 |
| Average | | 6.0 | 2.8 | 1.1 | 9.9 |
| Polyurethane | 72 | 15.6 | 10.1 | 11.8 | 37.5 |
| Do. | 80 | 9.1 | 4.4 | 8.8 | 22.3 |
| Do. | 100 | 14.2 | 3.0 | 0.8 | 18.0 |
| Average | | 13.0 | 5.8 | 7.1 | 25.9 |

The upper half of table 4 indicates that Red Delicious apples in the experimental polyurethane-pad packs sustained about the same amount of bruising as apples in the standard tray-pack early in the season. The lower half of the table shows that late in the season apples in the polyurethane-pad packs sustained substantially more bruising than apples in the standard packs. The shorter apple holding-times, the smaller size of the apples and the use of a more rigid box probably contributed to the lesser bruising in the polyurethane packs in the early shipments.

Tables 5 and 6 show the comparative condition on arrival of Extra Fancy Winesap and Golden Delicious apples in test shipments in experimental and conventional packs.

Table 5.--Condition on arrival of Winesap apples in specified packs, average of 4 test shipments to eastern markets, 1960-61

| Type of pack | Size | Amount of bruising | | | |
|---|---|---|---|---|---|
| | | Slight | Damage by bruising | Serious | Total |
| | Number | Percent | Percent | Percent | Percent |
| Tray-pack | 72 | 5.1 | 3.2 | 0.5 | 8.8 |
| Do. | 80 | 4.4 | 0.9 | 0.3 | 5.6 |
| Do. | 100 | 7.5 | 2.2 | 0.0 | 9.7 |
| Average | | 5.7 | 2.1 | 0.3 | 8.0 |
| Polyurethane | 72 | 13.5 | 1.7 | 1.0 | 16.2 |
| Do. | 80 | 18.8 | 6.9 | 4.7 | 30.4 |
| Do. | 100 | 16.5 | 1.0 | 0.0 | 17.5 |
| Average | | 16.3 | 3.2 | 1.9 | 21.4 |

Table 6.--Arrival condition of Golden Delicious apples in specified packs, average 3 test shipments to eastern markets, 1960-61

| Type of pack | Size | Amount of bruising | | | |
|---|---|---|---|---|---|
| | | Slight | Damage by bruising | Serious | Total |
| | Number | Percent | Percent | Percent | Percent |
| Cell-pack | 80 & 96 | 2.6 | 0.1 | 0 | 2.7 |
| Polyurethane | 64 to 100 | 10.2 | 7.2 | 0.6 | 18.0 |

Both the Winesap and Golden Delicious apples in the polyurethane packs sustained substantially more bruising than in the conventional tray-packs and cell-packs. The cupped pulpboard trays and the cells in the conventional packs isolated each apple and held it in the position in which it was packed. This was not true in the polyurethane packs. Terminal arrival inspections showed that many apples in the experimental packs were on their sides and on their calyx ends. Analysis of the bruising showed that the pads provided relatively inadequate protection from overhead weight.

## Polyurethane Place-Pack for Pears

To evaluate the use of polyurethane pads for pears, five full-carload commercial rail shipments were inspected upon arrival in eastern markets in 1961, by specialists of the Agricultural Marketing Service.

Anjou pears from controlled-atmosphere storage were tissue-wrapped and packed in full-telescope fiberboard boxes with polyurethane pads on top and bottom and between layers.

The pears arrived at terminal markets with but 0.2 percent slight bruising and no damage by bruising or serious bruising. Slight discoloration amounted to 5.3 percent; damage 0.4 percent; and serious discoloration, 0.1 percent. The condition of the pears in the experimental boxes was considered excellent, in comparison with similar pears reaching the market at the same time in standard wooden boxes.

Most of the discolored pears were found in a few boxes that had been packed with a "hump" instead of a flat pack. A "hump" pack causes looseness in the sides and ends and allows movement of the pears in the box during transit. The fine condition of the pears was attributed mainly to their shape and the fact that, in comparison with apples, pears can stand more pressure. The shape of pears, with their necks, permits better nesting of the fruit. Care should be taken in packing pears in the polyurethane place-pack to avoid excessive headroom, which results from the settling of the pack during transit. Compression pads on top, such as excelsior, should help.

## Apple Tray-Pack for Pears

Two controlled-test rail shipments of size-110 Anjou pears experimentally packed in conventional pulpboard tray-packs for apples and in the standard wooden boxes for pears were shipped to an eastern market in 1961. The apple trays differed slightly in design and came from two different manufacturers. Table 7 shows the condition on arrival of these pears.

Table 7.--Condition on arrival in eastern markets of Anjou pears in conventional and experimental containers, an average of 2 test shipments, 1961

| Container | Bruising | | | Discoloration | | |
|---|---|---|---|---|---|---|
| | Slight | Damage by bruising | Serious | Slight | Damage by bruising | Serious |
| | Percent | Percent | Percent | Percent | Percent | Percent |
| Standard wooden box | 7.8 | 0.0 | 0.0 | 1.7 | 0.0 | 0.0 |
| Apple tray-pack: | | | | | | |
| Type X | 1.7 | 0.0 | 0.0 | 11.1 | 0.0 | 0.0 |
| Type Y | 2.5 | 0.0 | 0.0 | 8.2 | 0.1 | 0.0 |
| Average | 2.1 | 0.0 | 0.0 | 9.6 | 0.05 | 0.0 |

The greater amount of bruising of fruit in the wooden boxes was due largely to lid cuts and pressure bruises from the wooden lid. These bruises, while slight on arrival, showed more clearly when the pears ripened. More discoloration occurred in the tray-packs than in the wooden boxes, because the wooden boxes can be packed more tightly. The pears apparently moved in the rounded apple cups during transit. This caused discoloration and may also cause a "duller" look on the skin of the pears. Better compression pads, such as shredded wood (excelsior), might help maintain a tighter pack in the pulpboard apple trays. Because of the different shapes of apples and pears, however, it may well be impossible to completely immobilize pears in tray cups designed for apples.

There may be storage problems in using a fiberboard box for pears, especially in cooling them. Pears in fiberboard boxes generally mature faster than pears in wooden boxes during the same storage time. Further study of this problem may result in better methods of storage.

## Five-Layer Pack for Size-88 Apples

The newly designed pulpboard trays for size-88 apples were evaluated in three controlled-test rail shipments to an eastern market. The new trays were designed to hold 17 and 18 apples. They were packed alternately five layers deep per box. The conventional size-88 trays held 22 apples per tray and were packed 4 layers per box. Table 8 shows the comparative condition on arrival of size-88 Red Delicious apples in both new and conventional packs.

Table 8.--Condition on arrival of size-88 Red Delicious apples in specified trays, average of three test shipments to an eastern market, 1961

| Pack | Amount of bruising | | | |
|---|---|---|---|---|
| | Slight | Damage by bruising | Serious | Total |
| | Percent | Percent | Percent | Percent |
| Standard: | | | | |
| 4 trays of 22 apples .. | 22.2 | 1.5 | 0.1 | 23.8 |
| Experimental: | | | | |
| 3 trays of 18 and 2 of 17 apples ..... | 9.2 | 0.5 | 0.1 | 9.8 |

Apples in the new trays sustained almost 60 percent less total bruising than apples in the conventional trays. With the alternating 17- and 18-place experimental trays the apples were staggered from layer to layer and their weight was more widely distributed than in the conventional trays (figs. 3 and 4). In the conventional trays the pressure was concentrated on the tops and bottoms of the apples and the bruises were deeper.

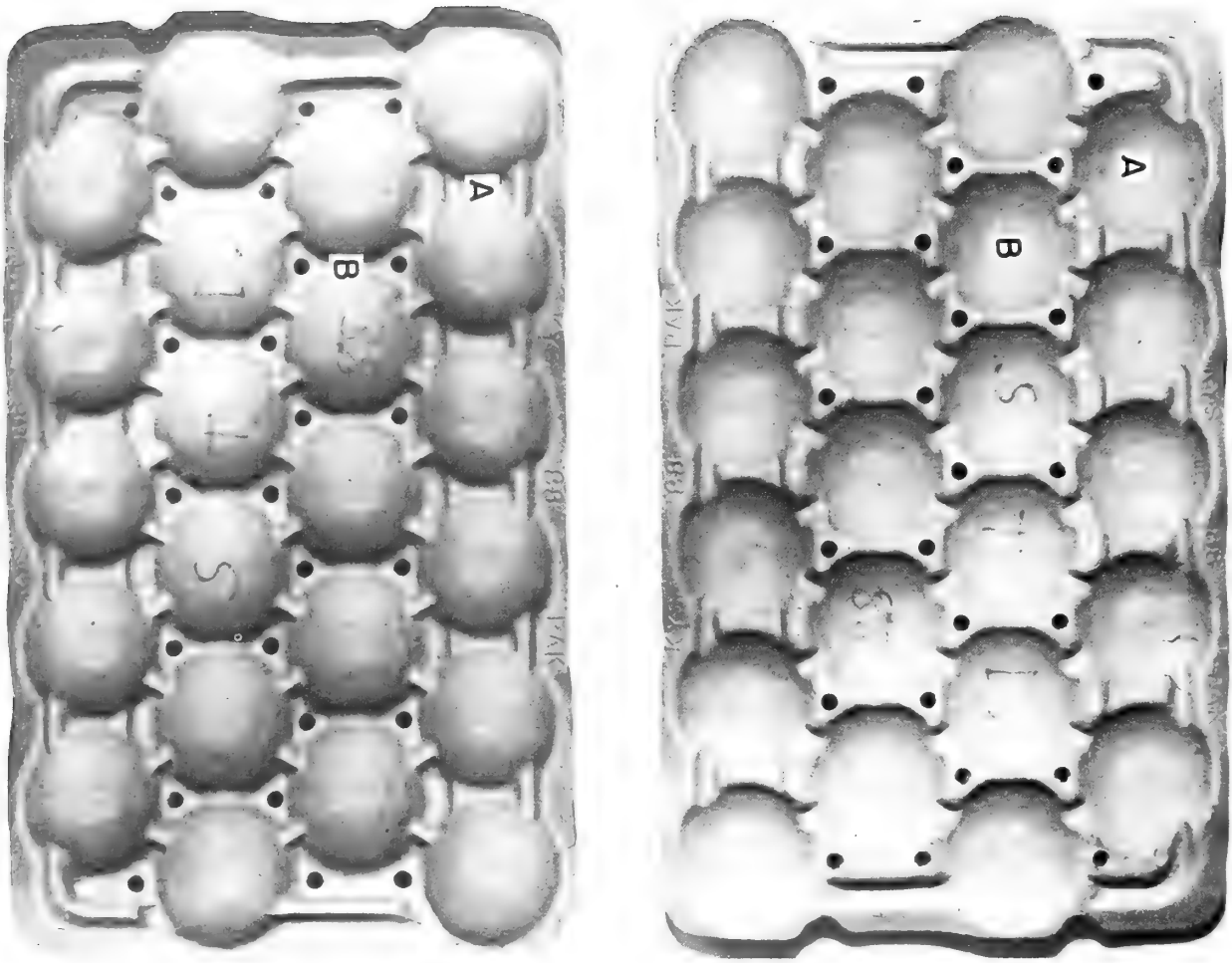


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Figure 3.--This is the standard 22-unit tray for size-88 apples. The direction of the tray is reversed (rotated 180 degrees) in alternate layers in the master container. Thus an apple in cup "A" in second layer (above) would be directly over the narrow space "A" (below). An apple in cup "B" (above) would be over space "B" (below), and so on. Each apple in the second layer, therefore, would exert its own weight, and the weight from higher up, primarily on two apples directly below it. This overhead pressure was the chief cause of a substantial amount of bruising.

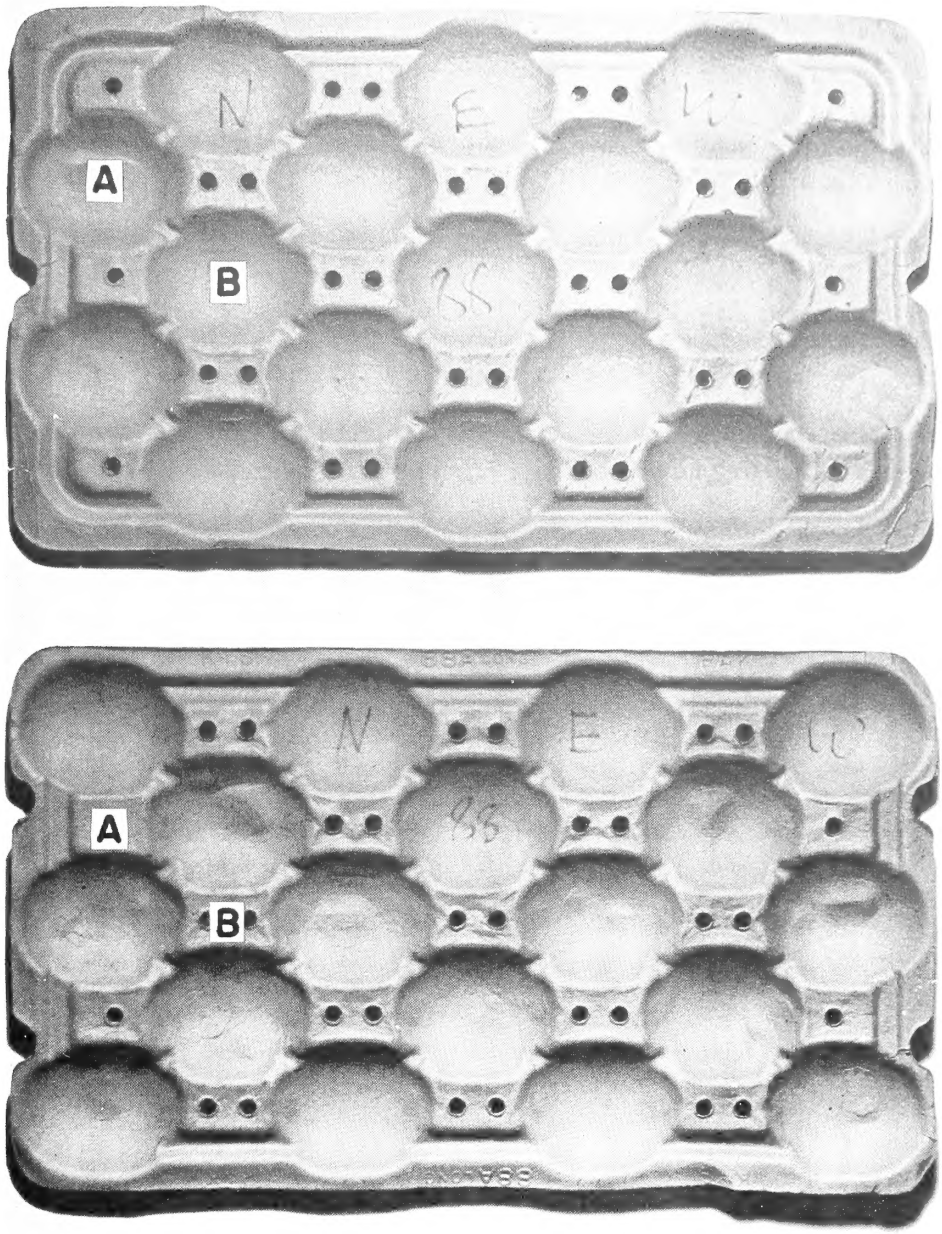


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Figure 4.--This photograph illustrates how the new trays for size-88 apples reduce bruising by better distributing overhead weight. The packer places the 18-unit tray (below) in the bottom of the shipping container and fills the cups with apples. He then inserts the 17-unit tray (above) and fills it. Note how apple in cup "A" (above) would nest down in space "A" (below). Similarly, apple in cup "B" (above) would nest in space "B" (below). In the first instance pressures from above would be distributed among three apples and a box wall; in the second instance among four apples.

The height of the pack of the conventional four-layer box at time of packing was even with the top of the inner case. Inspection upon arrival showed headroom, due to settling, of ¼ to ½ inch. The experimental five-layer pack, however, was about ½ to 1 inch above the inner case at time of packing. Upon arrival the pack had settled so that there was 1/8- to 1/4-inch headroom. Less headroom contributes toward less bruising.

## Polystyrene Foam Pads for Apples

Polystyrene foam layer pads in the conventional fiberboard apple box were tried out in limited experiments. The pads--3/8 inch thick--cracked and ruptured, permitting direct contact among apples in adjoining layers (fig. 5). Bruising, much of it severe, was in excess of 50 percent. Polystyrene foam has proved a good cushioning material for many other products and because it does not absorb moisture and become misshapen, as do some molded pulpboard trays, it offers promise in these respects. Also, it is comparatively inexpensive. Further tests are planned to test various densities and thicknesses of the pad.

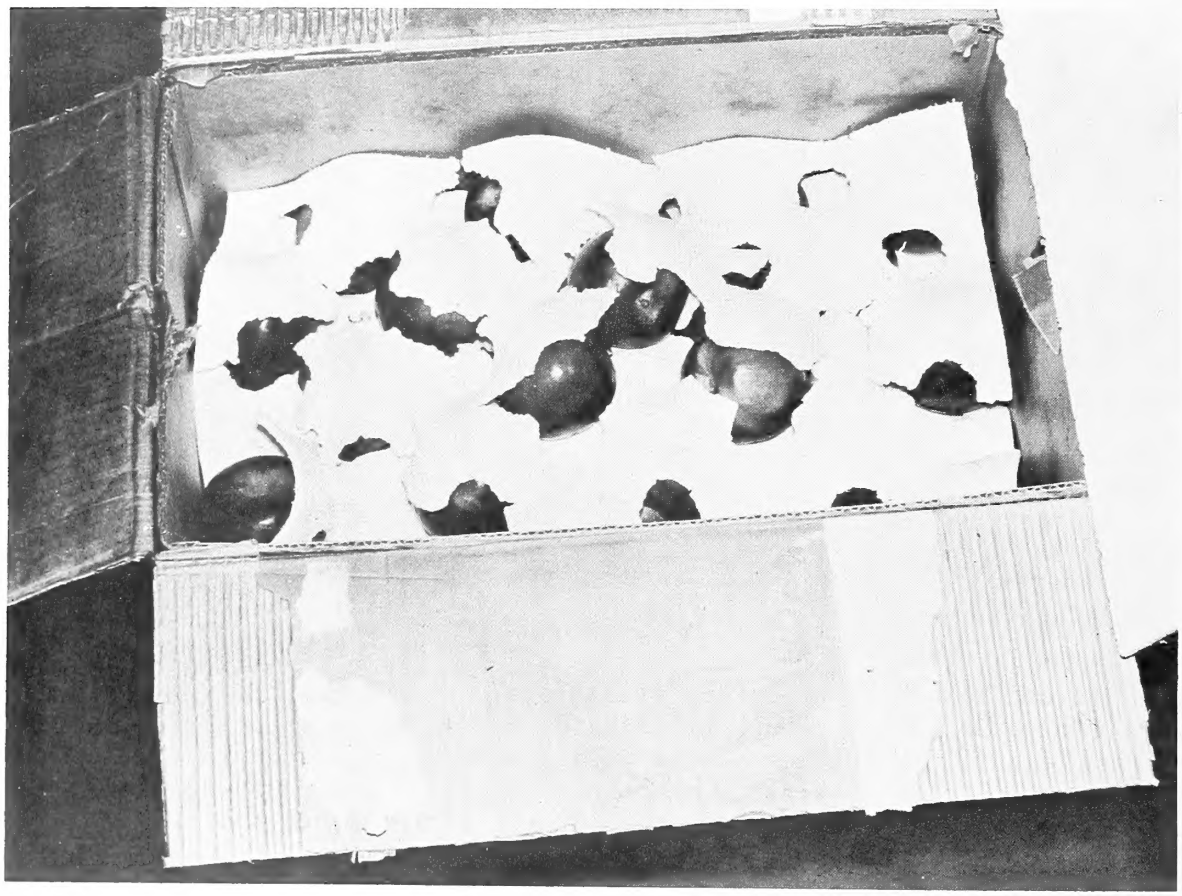

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Figure 5.--A layer of apples has just been removed from the top of the white polystyrene foam pad in this box. Note ruptures in pad and unprotected apples in layer below.



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